REVIEW OF CIVIL ENGINEERING PROGRESS.*

GENTLEMEN: Of all the important sections of the British Association, the one over which I have now the honor of presiding is, you will all I think admit at once, the most practical and most characteristic of the age. In future times, the present age will be remembered chiefly for the vast strides which have been made in the advancement of mechanical science. Other days have produced as great mathematicians, chemists, physicists, warriors and poets, but no other age has made such demands upon the professors of mechanical science, or has given birth to so many men of eminence in that department of knowledge. Though a member of the profession myself, I may venture before my present audience to claim that the civil engineer is essentially a product and a type of the latest development of the present century. Telford has admirably defined the profession of a civil engineer as "being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." This definition, written more than half a century ago, is wide enough to include all branches of engineering of the present day, although amongst those specifically mentioned the departments presided over by the railway engineer, the locomotive superintendent and the electrician will be looked for in vain. As Telford was beyond all question the most widely experienced and far-seeing engineer of his time, this little omission well illustrates and justifies my statement that the typical civil engineer of the day is a late product of the present century; for even Telford never forsaw the vast changes which railways, steam and electricity would evolve in the course of a few years

My predecessors in this chair have on several occasions stated their conviction that it was better for the author of an address to confine his attention to the particular department of engineering in which he had special knowledge than to wander over the whole field of mechanical science. A well-informed man has been defined to be a man who knows a little about everything and all about something. If you give me credit for being a well-informed engineer, I will endeavor to justify your good opinion by showing, while presiding at these meetings, that I know a little about steam navigation, and machinery generally; a little about iron and steel, and other manufactures, and I trust a good deal about the construction of railways, canals, docks, harbors, and other works of that class.

There have undoubtedly been published during the last fifty years many works of mark and merit, but the work which, above all others would, I think, have astonished and perplexed our ancestors, is the little one known to all the civilized world as "Bradshaw." This indispensable handbook of the nineteenth century testifies that the face of the country is dotted over literally with thousands of railway stations; that between many of these stations trains run at two-minute intervals, while the distance between others is traversed at a mean speed of nearly 60 miles an hour. The public are often justly indignant at the want of punctuality on some railways, but they should blame the management and not the engineers; for the daily conduct of the heavy traffic between England and Scotland shows, that, notwithstanding the constantly varying condition of wind and weather in this climate, a run of 400 miles can, on a properly laid-out railway, and with suitably designed rolling stock, be accomplished with certainty to the minute, if the management is not at fault. On the Great Northern Railway, for instance, of which I am consulting engineer, the 400 miles between London and Edinburgh is traversed in 9 hours, or, deducting the half-hour allowed at York for dining, at the mean rate of no less than forty-seven miles per hour including stoppages. A few months ago the Duke of Edinburgh was taken on the same line of railway from Leeds to London, a distance of 186¾ miles, in exactly three hours, or at a mean rate, including a stop at Grantham, of over sixty-two miles an hour. I know of no railway in the world where this performance has been eclipsed, and it will be, perhaps, both instructive and amusing to contrast with it the performance of the engines at the opening ceremony of the Liverpool and Manchester Railway, on September 15, 1830. A newspaper correspondent of the time, after describing many eventful incidents of his journey, proceeds as follows: "The twenty-four vehicles left behind were now formed into one continuous line, with the three remaining engines at their head; and at twenty minutes past five o'clock we set out on our return to Liverpool. The engines not having the power, however, to drag along the double load that had devolved upon them at a faster rate than from five to ten miles an hour (once or twice only, and that but for a few minutes, did it reach the rate of twelves miles an hour), it was past eight o'clock before we reached Parkside. Proceeding onwards, we were met on the Kenyon Embankment by two of the missing engines, which were immediately attached to the three which had drawn us from Manchester. We went still slower than before, stopping continually to take in water (query: to take breath), and creeping along at a snail's pace till we reached Sutton inclined plane, to get up which the greater part of the company were under the necessity of alighting and making use of their own legs. On reaching the top of the plane we once more took our seats, and at ten o'clock we found ourselves again at the company's station in Crown street, having accomplished the distance of thirty-three miles in four hours and forty minutes."

The incident of the passengers descending from a train headed by five engines to walk up an insignificant incline is, I think, worthy of being recalled to the remembrance of the traveling public, who are accustomed to see without astonishment a single engine rushing along with a train of a dozen heavy carriages at as high a speed as if it were running alone. We must do our immediate forefathers, however, the justice to remember that even they effected some considerable improvements in the speed of locomotion. For example, in 1763 the only public conveyance for passengers between London and Edinburgh was a single coach, which completed its journey in fourteen days, or at the average rate of 1¼ miles per hour. Strange as it may appear, there are at the present time many large fertile districts in Hungary where, owing to the absence both of road and water communications, a higher rate of speed cannot be attained in a journey of several days' duration.

An essential condition of the attainment of high speed on the railway is that the stopping-places be few and far between. The Great Northern express previously referred to makes its first halt at Grantham, a distance of 105 miles from London, and consequently but little power and time are lost in accelerating and retarding the speed of the train. In the instance of the Metropolitan Railway, on the other hand, the stations average but half a mile apart, and although the engines are as powerful as those on the Great Northern Railway, whilst the trains are far lighter, the average speed attainable is only some twelve miles an hour. No sooner has a train acquired a reasonable speed than the brakes have to be sharply applied to pull it up again. As a result of experiment and calculation, I have found that 60 per cent. of the whole power exerted by the engine is absorbed by the brakes. In other words, with a consumption of 30 lbs. of coal per train mile, no less than 18 lbs. are expended in grinding away the brake blocks, and only the remaining 12 lbs. in doing the useful work of overcoming frictional and atmospheric resistances.

Comparatively high speed and economy of working might be attained on a railway with stations at half-mile intervals, if it were possible to arrange the gradients so that each station should be on the summit of a hill. An ideal railway would have gradients of about 1 in 20 falling each way from the stations with a piece of horizontal connecting them. With such gradients gravity alone would give an accelerating velocity to the departing train at the rate of one mile per hour for every second; that is to say, in half a minute the train would have acquired a velocity of thirty miles an hour, whilst the speed of the approaching train would be correspondingly retarded without the grinding away of brake blocks. Could such an undulating railway be carried out, the consumption of fuel would probably not exceed one-half of that on a dead level railway, whilst the mean speed would be one-half greater. Although the required conditions are seldom attainable in practice, the broad principles should be kept in view by every engineer when laying out a railway with numerous stopping-places.

Nearly thirty years ago, when projecting the present system of underground railways in the metropolis, I foresaw the inconveniences which would necessarily result from the use of an ordinary locomotive, emitting gases in an imperfectly ventilated tunnel, and proposed to guard against them by using a special form of locomotive. When before the Parliamentary Committee in 1854, I stated that I should dispense with firing altogether, and obtain the supply of steam necessary for the performance of the single trip between Paddington and the city from a plain cylindrical egg-ended boiler, which was to be charged at each end of the line with water and steam at a high pressure. In an experimental boiler constructed for me, the loss of pressure from radiation proved to be only 30 lbs. per square inch in five hours, so that practically all the power stored up would be available for useful work. I also found by experiment that an ordinary locomotive with the fire "dropped" would run the whole length of my railway with a train of the required weight. Owing to a variety of circumstances, however, this hot water locomotive was not introduced on the Metropolitan Railway, though it has since been successfully used on tramways at New Orleans, Paris, and elsewhere. I am sorry to have to admit that the progress of mechanical science, so far as it affects locomotives for underground railways, has been absolutely *nil* during the past thirty years. The locomotive at present employed is an ordinary locomotive, worked in the ordinary way, except that in the tunnel the steam is condensed, and combustion is aided by the natural draught of the chimney alone, instead of being urged by a forced blast as on open portions of the line. Whether a hot-water, a compressed-air, or a compressed-gas locomotive could be contrived to meet the exigencies of metropolitan traffic is a question which, I think, might be usefully discussed at the present or some future meeting of the association.

A reference to the underground railway naturally suggests the wider question of tunnels in general. The construction of tunnels was not one of the novelties presenting itself to railway engineers, for many miles of tunnel had been driven by canal engineers before a single mile of passenger railway had been built in this or in any other country. To foreign engineers belongs the honor of having boldly conceived and ably accomplished tunnel works of a magnitude which would have appalled a canal engineer. I need only refer to the Mont Cenis Tunnel, over 7½ miles in length, commenced in 1857 and finished in 1870; the St. Gothard Tunnel, 9¼ miles in length, commenced in 1827 and finished in 1882; and the Hoosac Tunnel, 4¾ miles in length, commenced in 1854 and finished in 1875. In all cases rock of the hardest character had to be pierced, and it is needless to remark that without the aid of the machinist in devising and manufacturing compressed-air machinery and rock-boring plant the railway engineer could not have accomplished his task. Intermediate shafts are not attainable in tunnels driven through great mountain ranges, so all the work has to be done at two faces. In the case of the Mont Cenis Tunnel the mean rate of progress was 257 ft. and the maximum 400 ft. per month. In the St. Gothard Tunnel the mean rate was 429 ft. and the maximum 810 ft. In the Hoosac Tunnel the average rate was 150 ft. per month.

Tunnels under broad navigable rivers and estuaries have been a subject of discussion by engineers for at least a century, but the only one at present completed is the unfortunate and costly Thames Tunnel. Two important works of the class are, however, now well in hand, namely the Severn Tunnel at Portskewet, and the Mersey Tunnel at Liverpool. Having reference to this fact, it will be interesting to quote the following passage from a letter addressed to the press by a Mr. Thomas Deakin on March 6, 1835, that is to say, more than forty-seven years ago. Mr. Deakin writes: "The Great Western Railroad from London to Bristol will be accomplished no doubt, and why not continue it under the Severn mouth, near Chepstow, Monmouthshire, through Glamorganshire, and to Milford Haven in Pembrokeshire? It would then traverse the coalfield of South Wales throughout its whole extent—a tract of country possessing also inexhaustible stores of ironstone. A tunnel was once proposed to be formed under the Mersey at Liverpool, and, had it not been for the failure of the Thames Tunnel would most probably have been carried into effect." It is not a little singular that the two tunnels thus forshadowed by Mr. Deakin should both be in hand at the present moment.

Undoubtedly the numerous accidents which occurred during the construction of the Thames Tunnel, together with its enormous cost of about £1,500 per lineal yard, and the eighteen years occupied in its construction, destroyed the chance of any other projected subaqueous tunnel for many subsequent years. One lesson enforced by the Thames Tunnel was the necessity of leaving a reasonable thickness of ground between the water and the tunnel. In the Severn Tunnel the minimum thickness is 40 ft., and in the Mersey Tunnel 22 ft. The width of river at the point of crossing at the former tunnel is two and a quarter miles, and the maximum depth of the rails below high water, 163 ft. In the case of the Mersey Tunnel the width is nearly three-quarters of a mile, and the depth 144 ft. The Thames Tunnel, as almost every one knows, was carried on by means of a special contrivance termed by Brunel a "shield." No special appliances have been adopted in the case either of the Severn or the Mersey tunnel. Both are driven in the ordinary way, but of course enormous pumping power is required and has been provided.

Where no special appliances are used in the construction of a subaqueous tunnel, it will be clear to all that an unknown risk is encountered. All

* Address of Jno. Fowler, Mem. I. C. E., before the British Association.

may go well, and the engineer will then justly receive congratulations from everyone for his boldness and success. But, on the other hand, something may go wrong, even at the last moment, and I fear the engineer then would be abused no less roundly by the unthinking public for his temerity and consequent failure. It would be a "Majuba Hill" incident over again, and if the accident caused much loss of life the engineer probably would envy the fate of the brave but ill-starred General Colley, who at least fell with the victims of his rashness.

In many cases of tunnels under estuaries, special appliances could be used which would obviate all risk and make the successful completion of the work a mathematical certainty. A tunnel under the Humber, about one and a half miles in length, projected by myself in 1873, the bill for which was subsequently passed by the Commons and thrown out by the Lords, was a case in point. The bed of the Humber is of very fine silt, and I proposed to build the tunnel in lengths of 160 ft., under the protection of rectangular iron caissons 160 ft. long, by 42 ft. wide, sunk by the pneumatic process. As the pressure of the air in the caissons would always be slightly in excess of that due to the head of water in the river, no interruption from influx of water could ever occur, and the operation of building the tunnel in lengths inside this huge diving-bell would be as certain and free from risk as the every-day work of sinking a bridge pier by the pneumatic process.

A tunnel over a mile in length now in progress under the Hudson River at New York is being driven through a silty stratum by the aid of compressed air, and with a certain amount of success, as only some twenty men have been drowned up to the present time. The principle upon which the compressed air is used is, however, a false one, since it is merely forced into the tunnel with a view to uphold the ground by its pressure, like so much timbering, and not to keep out the water on the principle of a diving-bell. It is clear, therefore, that the completion of the Hudson River Tunnel, if the present system be persevered in, is purely a matter of conjecture, and all we can do is to hope for the best. The same remark applies, of course, to the Severn Tunnel and the Mersey Tunnel, although in those cases the character of the ground is such that the contingencies are small in comparison with those encountered in the construction of the Thames Tunnel and the Hudson River Tunnel. Nevertheless, as I have already observed, unless special appliances of the nature of the pneumatic process be used, a subaqueous tunnel, whether it be the Channel Tunnel itself or one but a few yards in length, must necessarily present an unknown risk. The prototype of all these tunnels is the one commenced at Rotherhithe in 1809, which was successfully driven a distance of 900 ft. under the Thames, and failed when within little more than 100 ft. of the opposite shore. A tunnel about 1¼ miles in length was commenced about ten years ago under the Detroit River in America, but was abandoned in a similar manner. So far good fortune has attended both the Severn and the Mersey tunnels, and there is, I am glad to say, every chance of its continuing.

That the series of mishaps with the Thames Tunnel, and the consequent postponement of all other projects for subaqeous tunnels, were due to errors in design and want of foresight on the part of the engineer is patent to every one now, and was foreseen by at least one acute contemporary of Brunel himself. Only a few months ago, when turning over the leaves of an old periodical, I became aware of the fact that a scheme, identical in all its main features with my Humber Tunnel project, had been suggested for adoption in the case of the Thames Tunnel, in lieu of the plan proposed by Brunel. Writing in December, 1823, or fifty-nine years ago, the author of the project, a working smith of the name of Johnson, says: "I propose to construct the Thames Tunnel without cofferdams by making it in parts, 28 ft. in length, each part having the ends temporarily stopped up, and being constructed on the same principle as the diving-bell. The men dig from the inside round the edge as if sinking a well, and throw the earth toward a dredger, the buckets of which work some feet below the bottom of the excavation. Each length will be suspended between two vessels and be conveyed to the place where it is to be let down." A description of the mode of connecting the several lengths is given, and I may add that the tunnel blocks had a sloping face to tend to bring the faces of the joints together, a plan since adopted with the huge concrete blocks at Kurrachee and other harbors. There is not a flaw in the design from beginning to end, as modern experience in the sinking of numerous bridge piers on precisely the same plan has amply demonstrated. It is beyond all doubt that if the design of this working smith had been adopted in lieu of that tendered by Brunel, the Thames Tunnel would have been completed in a couple of years, instead of eighteen years, and at a cost of about £300 per yard instead of £' 500.

If another tunnel be constructed under the Thames, which is far from improbable, as the requirements of below-bridge traffic necessitate some such means of communication, I venture to predict it will be built in accordance with the plan suggested fifty-nine years ago by the working smith, and not on that of Brunel's Thames Tunnel, or of any other tunnel yet carried out.

At the beginning of the present century a committee was appointed to consider the "practicability of making a land communication by a tunnel under the River Forth, at or near Queensferry." In a report dated November 14, 1805, it was recommended that a double tunnel should be constructed, at an estimated cost of £164,000, or at the rate of £30 per yard, exclusive of shafts and pumping. The surveyors reporting grounded their belief in its practicability upon the fact that Barrowstowness coal workings had been carried under the same Firth for a mile, and that at Whitehaven coal was worked for the same distance under the Irish Sea, in both places less water being met with under the sea than under the the land. The report concludes in the following words: "That a more easy and uninterrupted communication betwixt every part of a country increases the intercourse of commerce, arts, and agriculture, all must know. Ferries are still and often a formidable bar in the road. Of these in this country, the one under review at Queensferry is perhaps the most conspicuous. It is in fact the connecting point betwixt the north and south of Scotland, and, indeed, of the realm; and in this point of view the improvement of it must be considered a national object." These words are as true and applicable to the case in 1882 as they were in 1805. A ferry still is the only means of communication across the Forth at Queensferry, though the traffic has increased a hundredfold. Parliament, by the passing of the Forth Bridge Act during the present session, has given a practical recognition of the truth of the statement in the above-quoted report, that the improvement of the Forth passage is a "national object."

As you will receive a paper on the Forth Bridge from my partner, Mr. Baker, I will not trouble you with details of the proposed structure at the present moment. I may state, however, that after a careful consideration of the difficult problem, in concert with my able colleagues, Mr. T. E. Harrison, the Chief Engineer of the North-Eastern Railway, and Mr. W. H. Barlow, Chief Engineer of the Midland Railway, we unanimously advised the directors of the Forth Bridge Company to abandon the project for a suspension bridge, and to construct a steel girder bridge of the unprecedented span of 1,700 ft. The total length of the structure is 1½ miles, and it includes two spans, as aforesaid, of 1,700 ft., and two of 675 ft. over the navigable channels on each side of Inchgarvie. The execution of the work has been intrusted to me, and my intention is that the Forth Bridge shall be not only the biggest but the strongest and stiffest bridge yet constructed.

Although great navigable rivers offer the most serious impediments to lines of communication lying at right angles to the direction of the stream, and necessitate such formidable undertakings as the Forth Bridge, with a clear headway of 150 ft. above high water, and the Severn Tunnel at a depth of 163 ft. below the same datum, still it must be remembered that such rivers were the earliest, and are yet the cheapest, highways for inland communication. Antwerp, the third port in the world, ranking only after London and Liverpool, owes its commercial importance undoubtedly to the Scheldt, which affords admirable water carriage for a distance of 60 miles from the sea-coast inland. London, similarly, is an inland port situated about 50 miles up the Thames; hence one-half of the distance between Antwerp and London is made up of fine rivers capable of being navigated by the largest ocean-going steamers. The practical result of the existence of this splendid line of natural communication is that iron girders and rails can be conveyed from the heart of Belgium to the metropolis at a far lower price per ton than from any iron-works in this country. Unfortunately, the southern coast of England and the opposite coast of France are indented by no such rivers as the Thames and the Scheldt, or we should never have heard of the horrors of the "middle passage" in "cockleshell" boats, or of the Channel Tunnel.

To realize, however, the important part which rivers play in facilitating inland communication, it is necessary to glance at the other side of the Atlantic. In Canada, for instance, we have the great inland port of Montreal, where Transatlantic steamers anchor some 500 miles from the coast. The very term "stream of traffic" suggests a river, and the St. Lawrence well illustrates it. Into some small forest tributary of the Ottawa the lumbermen slide a log of timber, and many months after will that log, with thousands of others, forming together a huge raft, with huts upon it for the accommodation of the care-takers, be found pursuing its slow but ever-continuing progress down the St. Lawrence to Quebec, where it will be shipped to this country.

In Egypt for countless ages the "ship of the desert" and the boats of the Nile constituted the only means of communication. Wheeled carriages were practically unknown, although as long ago as 1832, Mehemet Ali bewildered the pilgrims by starting off for Mecca across the desert in a Long Acre barouche. But the Nile holds an exceptional position amongst the rivers of the world, for not only was it until quite recently practically the sole means of inland communication for the country through which it flows, but it was, and still is, literally the life of Egypt, since without Nile water there would not be a green spot in the whole of that now fertile land. Having filled the office of consulting engineer to the Egyptian Government for seven years, I have had occasion to give particular attention to the Nile, and I may state that in an average year that river conveys no less than 100,000 million tons of water, and 65 million tons of silica, alumina, lime and other fertilizing solids down to the Mediterranean. The Nile begins to rise about the middle of June, at which time the discharge averages about 350 tons of water per second, and attains in September a height of from 19 ft. to 28 ft., and a discharge of from 7,000 to 10,000 tons per second.

Napoleon the Great said that every drop of Nile water should be thrown on the land, and he was right so far as Low Nile discharge is concerned. The cultivated lands in the provinces of Lower Egypt have an area of 3 million acres, and to irrigate this effectually at least 30 millions of tons of water per day would be required, an amount somewhat exceeding the whole of the Low Nile discharge. At present the irrigation canals are totally inadequate to convey this quantity, and imperfect irrigation and consequent loss of crops is the result. In many instances a couple of men labor for a hundred days in watering by shadoof a single acre of ground, all which amount of labor might be dispensed with if the barrage of the Nile were completed, and a few other works carried out, the whole of which would be paid for handsomely by a water rate of 2s. an acre. You will gather, therefore, that I do not think the resources of Egypt have yet been fully developed, magnificent as they even now are, having reference to the size of the country.

It is hardly necessary to say that a network of canals laid out with a view to irrigating the lands of Lower Egypt can also be used at any time in the event of war for the offensive or defensive flooding of the whole or any part of the said lands. Except for the work of man, Lower Egypt for four months in the year would be simply the bed of a river, and for the remaining months a mud bank. Long before the historic period, however, the Nile had been embanked, and canals, such as the Bahr-Jusef, had been formed; the first, to keep the floods off the land, except in desired quantities; and the second, to run off the inundation waters as soon as the fertilizing matters in suspension had been deposited on the lands. Should the inhabitants of Egypt neglect to maintain the works of their ancestors, successive floods would quickly destroy the embankments and wash the light material into the canals. Thus the whole surface of the country would again be leveled, and the land of Egypt would revert to its primitive condition of being a river's bed for one-third of the year, and probably a malarious swamp for the remainder.

It is hardly possible to refer to Egypt without saying a few words about the Suez Canal. Farseeing people, including the late Khedive, have long been of the opinion that another ship canal will be required in Egypt. In 1876 I submitted to His Highness, in accordance with my instructions, detailed plans and estimates for such a canal from Alexandria through Cairo to Suez. The total length of the canal was 240 miles, and with the same width as the existing Suez Canal the estimated quantity of excavation was 160 million cubic yards.

An interesting and significant incident in the history of the Suez Canal occurred in May, 1878, when a fleet consisting of ten steamers and sixteen sailing vessels passed through with 8,412 native troops bound from India to Cyprus. During the same year no less than 58,274 soldiers traversed the canal. Since 1878 events have marched rapidly, for no one then foresaw that the next important movement of British troops canal-ways would be of a nature hostile in appearance, if not in fact, to the inhabitants of Egypt. The announcement that French and not British troops were to hold the canal was received by the public with an expression of surprise and perhaps of slight resentment, because no one can dispute the vital importance of the work to this country. Periodically the question of the Euphrates Valley Railway is revived, and indeed quite recently I have had to reconsider the question professionally, but this route can never rival the existing one by the Isthmus of Suez.

The inauguration of steam navigation to India was much delayed by the vacillation of the authorities respecting the Suez and the Euphrates Valley routes. Happily, however, the Arabs stole the first bag of mails that went by the Euphrates, and

so in 1834 a committee of the House of Commons finally resolved that "steam navigation between Bombay and Suez having in five successive seasons been brought to the test of experiment, and the practicability of that line being established, it be recommended to His Majesty's Government to extend the line of Malta packets to Egypt to complete the communication between England and India. Nothing appears to have been done during the next two years, but in 1837 a new paddle-wheel steamer, the Atlanta, of 650 tons, steamed out to Calcutta round the Cape in ninety-one days and was put on the Red Sea station. She left Bombay with the mails on Oct. 2, 1837, and arrived at Suez on Oct. 16. The mails were carried across the desert by camels, and down the Nile to Alexandria in four days, where they remained until H. M. S. Volcano took them on board on Nov. 7. At Malta, on Nov. 16, they were transferred to H. M. S. Firefly, and finally were landed in this country on Dec. 4, having been in all sixty-three days in coming from Bombay to England. At the present time about eighteen days are occupied in carrying the mails from Bombay via Brindisi to London.

The town of Southampton, where we are now assembled, has always held a distinguished position in connection with the development of improved communication with our Eastern empire. The opening of the first section of the railway from London to Southampton was coincident with the establishment of steam navigation via Egypt to India, and in the same year the French engineers at Cario completed their studies for the proposed railway across the desert of Suez.

A few months later the London public were startled by an advertisement headed "Steam to New York," and 94 passengers were plucky enough to embark at London, on April 4, 1838, in the Sirius, of 700 tons and 320-horse power, for New York, where they arrived on the 22d, having performed the voyage in seventeen days from London, and fifteen days from Queenstown. The Great Western sailed from Bristol on April 7, and arrived at New York a few hours after the Sirius, and thus was the great problem of steam navigation to America successfully solved, by vessels of small size, and capable of maintaining a speed of but eight to nine miles an hour. I need hardly remind you that since the year 1838 the ships conducting the enormous traffic between Europe and America have been of ever-increasing size and speed. Thus the Britannic, built in 1874, has an extreme length of 468 ft., a beam of 45 ft. 3 in., a displacement of 8,500 tons, and a speed of 16 knots per hour; whilst the Servia, built in 1881, has an extreme length of 530 ft., a beam of 52 ft., a displacement of 13,000 tons, and a speed of 18 knots, and the City of Rome, built in the same year, has a length of 600 ft., a beam of 52 ft. 3 in. and a displacement of 13,500 tons. Another Atlantic liner, the Alaska, having a length of 500 ft., a beam of 50 ft., and a displacement of 12,000 tons, attained a speed of 18½ knots on the measured mile, and has done the distance between Queenstown and New York in 7 days 4 hours and 32 minutes, and the return voyage in 6 days and 22 hours, a mean ocean speed of, say, 17 knots per hour, or more than double that of the first steam vessels trading to America.

The present generation has grown so accustomed to the embodied results of the progress of mechanical science, that it has long ceased to wonder at big ships, or at any other novelty. To realize what has been attained, it is necessary to place ourselves as far as possible in the position of our immediate ancestors, and to look at things through their spectacles. With this view, and to give you some scale of comparison to measure the size of the present Atlantic liners by, I will quote a short passage from a newspaper of September 19, 1829, where reference is made to a vessel then under construction, of about the size of one of the much abused "cockleshells" performing the Channel service between Dover and Calais. "The Dutch have been engaged for the last five years in constructing and equipping a steamboat of extraordinary magnitude, in order to facilitate the communication between Holland and Batavia. It has four masts; is about 250 ft. long; and has been appropriately christened the Monster. In consequence of her great length, she hung when going off the slips, and it was some days before she was fairy launched, a circumstance which gave the wits of Paris occasion to remark that their Dutch neighbors were so determined to excel all other nations in the magnitude of their steamboats that they had built one so long that it was several days running off the stocks. One of the most remarkable features of this enormous vessel is her extreme narrowness as compared with her length, her greatest breadth of beam being only about 32 ft. The great size of this vessel will bring to the recollection of our readers the Columbus, which was built in the river St. Lawrence in 1824, and made the passage to England in safety, but was afterwards broken up on account of her unmanageable bulk. We shall not be surprised to find that a similar fate awaits the Monster, and for a similar reason."

The Channel boat Albert Victor, now on the Folkestone station, is of the same length as the Monster, namely, 250 ft., whilst the beam of the former is but 29 ft., instead of what the critic of 1829 termed the "extreme narrowness" of 32 ft.

The successive attempts at mitigating the discomforts of the Channel passage by the swinging saloon and twin steamers of Sir Henry Bessemer and Captain Dicey have gradually prepared the way for what I believe will be the next and important step of establishing Channel communication by means of large floating stations, or ferry-steamers, capable of traversing the narrow sea between England and France in little more than an hour. Ten years ago I applied to Parliament for powers to carry out this project, and obtained the unanimous sanction of a committee of the House of Commons. The bill was, however, thrown out in the House of Lords by the casting vote of the chairman.

What was practicable at that time has now become comparatively easy, owing to the introduction of steel into shipbuilding, and the improvements which have been effected in marine engines and mechanical appliances generally.

Whether the over-sea or under-sea mode of crossing the Channel—the ferry or the tunnel—is to be the adopted scheme will soon be determined. It may be that both will be carried out, and then at least all tastes will be met, and all anticipations respecting the resulting increase in traffic, both in goods and passengers, between the two countries will be brought to the test of experience. However this may be, I am very pleased to be able to announce that my friends Mr. Abernethy and Mr. Clarke Hawkshaw will read papers on the subject, the former on the over-sea, and the latter on the under-sea plan, and I shall be disappointed if the papers do not lead to an interesting and valuable discussion.

In few departments of the engineer's work has such progress been made as in that of steam navigation. When in 1820 steamships were first used for conveying merchandise as well as passengers, the tonnage of the whole of the steam traders of this country, it is stated, amounted to but 505 tons. At the present time the corresponding figure is 2,500,000 tons. Did time permit I would say more on the subject, but I fear that in speaking at all upon steamships I have departed somewhat from my avowed intention of keeping within the sphere of engineering, in which I have chiefly worked. My apology must be that a discussion of railways led me to a consideration of tunnels and bridges, and this naturally suggested a reference to the rivers necessitating the construction of the said tunnels and bridges. From river traffic to ocean traffic is but a step, and so I have been insensibly led to touch upon the wonderful results achieved in recent times by naval architects and mechanical engineers.

I will not similarly err in troubling you with any remarks of mine upon the no less wonderful results achieved by electricians. A description of the work done by my friend Dr. Siemens during the past quarter of a century would in itself constitute a concise history of electrical science. Remembering, however, the warning of King Solomon, that "he who praiseth his friend with a loud voice, it shall be counted a curse to him," I will refrain from referring to Dr. Siemens, or to my immediate predecessor in this chair, Sir W. G. Armstrong, and conclude my address at once with a sincere wish that the present session of the British Association may prove not less interesting and productive of benefit to science than have any of those which have preceded it.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page 328.*)

CCCLXXXIII.—ANNAPOLIS.

Annapolis, Maryland, in lat. 38° 45' N., long. 76° 20' W., is on the Severn River on undulating ground.

It was settled in 1620 and incorporated as a city about 1670. Water-works were built by a private company in 1866, after plans of Williams R. Hutton, C. E. The supply is procured from a number of springs and small streams, the water from which is collected in one stream and diverted by a dam into a circular well, whence it is pumped by two Worthington duplex steam pumps, one with 10-in. water cylinders erected in 1866, the other with 12-in. cylinders erected in 1881, lifting the water 125 ft. through a 10-in. cast-iron force main into a reservoir built in excavation and embankment, 127 ft. square at water surface and 16½ ft. deep, holding 1,250,000 gallons. The banks are puddled with clay and paved with granite. A brick trough is constructed 8 ft. under the bottom of the reservoir and covered with wooden slats ½ in. apart on which coarse gravel is laid, with layers of finer gravel on top, and a foot of sand over all. Through this the water filters, and is then conducted 4 miles to the city through a 10-in. main. This was at first of wrought iron and cement, which frequently broke and was replaced in 1879 with cast iron.

Distribution is by 7½ miles of wrought-iron and cement pipe of from 10 to 4 in. diameter, with 30 fire hydrants, 40 gates and 500 taps. There are 5 meters in use. The city pays $10 per annum for each fire hydrant. Service pipes are of galvanized iron.

The population in 1880 was 6,500. The daily consumption in 1881 was 250,000 gallons.

The capital stock of the company is $61,000. The works have cost $125,000. The bonded debt is $34,000 at 6 per cent. interest.

The expenses for the year ending March 1, 1882, were $10,955 66. Extraordinary expenses and repairs amounted to $6,047.36. The receipts were $16,209.73.

Alexander Randall is the President and Superintendent and James H. Hodges Secretary.

CCCLXXXIV.—QUINCY, ILL.

Quincy, Illinois, in lat. 39° 57' N., long. 91° 25' W., is on magnesian limestone bluffs, 165 ft. above the Mississippi River.

Settled in 1821, it was laid out as a town in 1825, and incorporated as a city in 1840.

Water-works were built in 1873 by a private company after plans of Edward Prince, taking the supply from the river. A 20-in. cast-iron pipe extends into the river, conducting the water to a double-walled brick well. The water enters the outer well through a wire screen and passes around three-quarters of the annular space and then enters the inner well, 30 ft. in diameter. From this it is lifted 235 ft. by a Worthington compound duplex steam pump into a reservoir built in excavation and embankment 412 by 250 ft. and 22 ft. deep. The inner slopes are puddled and paved with a 16-in. dry stone wall. The bottom is puddled. The effluent pipe has flexible joints. This reservoir is recently built. The supply at first was pumped into two tanks holding 150,000 gallons. In 1877 a reservoir holding 5,000,000 gallons was built.

Distribution is by 20 miles of cast-iron pipes, of from 20 to 4 in. diameter, with 81 fire hydrants, 30 gates and 250 taps. There are 7 meters. The city pays $15,400 per annum for fire hydrants. Lead, enameled and galvanized iron service pipes are used.

The population in 1880 was 27,275. The daily consumption in 1881 was 750,000 gallons.

The capital stock of the company is $500,000. The works have cost $450,000. No further financial statements are given.

Lorenzo Bull is President, and Edward Prince acting as Superintendent during the absence of William B. Bull, the regular Superintendent.

The receipt of statistics, as follows, is acknowledged with thanks: From James H. Hodges, Secretary, statistics of the water-works of Annapolis, Md. From Edward Prince, Superintendent, statistics of the water-works of Quincy, Ill.

RAILROADS IN MISSOURI.—The seventh annual report of the railroad commissioners of Missouri has just been published. It states that seventeen new companies have been organized during 1881. The most important of these are the Kansas City, Springfield & Memphis road, from Springfield, Mo., to a point opposite Memphis, Tenn.; the Ozark Iron Mountain Railway, to run from the St. Louis, Iron Mountain & Southern in Washington or St. Francois County, in a southwesterly direction through Iron, Shannon, Dent and Texas counties, to an intersection with the Kansas City, Springfield & Memphis road in Texas County; the Chester, Iron Mountain & Western Railroad from Chester to Salem; the Salem & Little Rock Railroad from Salem to the South boundary of the state, and the Hannibal & Southwestern Railroad from Hannibal to Brownsville, in Saline County, and to the western boundary of the state. The largest number of miles of road built in any year was 580 miles built in 1871. The following statement shows the capital stock and debt on the 4,077 miles of road in the state:

Amount of stock reported	$12,185,700
An average per mile of road of nearly	30,000
Total funded debt on same	133,607,500
Average per mile nearly	33,000
Total stock and bond liabilities	254,918,200
Average per mile nearly	63,000

The number of companies operating railroads in the state is 25, but over 95 per cent. of the whole number of miles of road in the State of Missouri is controlled by ten companies, and over 50 per cent by three companies. With regard to more than one-half of the railroad mileage of the state, the commissioners say there is no competition. At St. Joseph there are three interests, at Hannibal four, at Moberly one, and Sedalia one. There are 700 freight stations in the state, at 6 per cent. of which there is competition, and 94 there is no competition. The passenger rates for roads of the first class are 3 cents per mile, and for roads of the second and third class 4 cents per mile. The roads of the first class are given as follows: Chicago & Alton, from Louisiana to Kansas City; Chicago, Rock Island & Pacific, from Louisville to Leavenworth; Hannibal & St. Joseph; Kansas City, St. Joseph & Council Bluffs; Missouri, Kansas & Texas; Missouri Pacific; St. Louis, Iron Mountain & Southern, and the Wabash, St. Louis & Pacific.

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AND
AMERICAN CONTRACT JOURNAL.

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GEO. H. FROST.....EDITOR AND PROPRIETOR.
S. D. V. BURR.....ASSOCIATE EDITOR.

SATURDAY, SEPTEMBER 23, 1882.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe, $5, payable in advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

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Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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AMERICAN SOCIETY OF CIVIL ENGINEERS.

At the regular meeting of the Society on Wednesday evening, Oct. 4., Senor Duc Francisco De Garay, Chief Engineer of the Drainage of the Valley of Mexico, will be present, and will explain and illustrate the methods and conditions relating to the above interesting engineering work. In view of the important industrial developments of Mexico, consequent on the railway building now progressing there, the subject is one of great interest, not only to engineers, but to the general public. Members of the society will please to invite their friends to attend this meeting.

THE AMERICAN INSTITUTE.—The fifty-first fair of the American Institute was opened on the 27th inst., at the fair building, Third avenue and Sixty-fourth street. Although the exhibits, especially in the machinery department, were not all in place, the number and importance promise to excel those of former years. The aim of the Institute is a most worthy one—to aid in the development of agriculture, commerce, manufactures, and the arts, and to encourage American industry in all its branches.

THE LATE STORM.—Undoubtedly one of the severest storms that has visited this section of the country for the past few years occurred during the last three days of the past week. New York city was the center and the damage done to roads, bridges, dams and crops within a radius of 200 miles cannot be estimated. The strong east and northeast winds, blowing continuously for several days, produced high tides which proved disastrous to works on the coast. The rain fell steadily and gently during Thursday and Friday and so completely soaked the ground that the outpouring that followed had no work to do but to change brooks and rivulets into torrents that swept dams and bridges before it. The Board of Freeholders of Union County, New Jersey, place the damage at $100,000, twenty-seven bridges needing repair or reconstruction. This is not an isolated case, but only one of many, as other sections in the same and other states suffered as severely. Many bridges upon the Rahway, Passaic and Raritan rivers were totally washed away. Travel was impeded on all the railroads leading into this city.

OBITUARY.

ASHBEL WELCH, President of the American Society of Civil Engineers, died at his home at Lambertville, N. J., on Monday, the 25th inst.

Mr. Welch was born in Madison County, this State, Dec. 4, 1809. He came of old New England stock, being seventh in descent from Governor William Bradford, of Plymouth. He was educated at the Albany Academy at the time Professor Henry was a teacher there, and began his professional career when 18 years old, under his brother, Sylvester Welch, who was then engaged on the Lehigh Canal in company with W. Milnor Roberts, Solomon W. Roberts and other engineers, who afterward became eminent in their profession. Mr. Welch soon became favorably known, and was intrusted with engineering undertakings of great magnitude and importance, and became one of the most prominent of the early constructors of canals and railroads.

In 1830 he became connected with the Delaware and Hudson Canal Company, and was in charge of that work for many years, building during that period the Belvidere Delaware Railroad. In 1852 he successfully accomplished an undertaking, the difficulty of which can only be appreciated by those who have had similar tasks—of doubling the capacity of the canal and locks within the period of three months, in the winter. This work was accomplished at a cost less than the estimates. From 1862 to 1867 he was Executive Officer of the Joint Companies in New Jersey, and assisted in effecting the consolidation of the Joint Companies with the New Jersey Railroad Company. Until 1871, when the Pennsylvania Railroad Company took possession of their lease, he was General President of the Associated Companies, and since then has been President of some of the roads and also of the organization known as the United Companies. From 1840 to 1845 Mr. Welch was engaged with Captain Robert F. Stockton in making the experiments that resulted in the building of the steamer "Princeton," the first propeller ship ever constructed in this country, and in the building and introduction of large ordnance. He devised a system of safety signals for railroads which is now extensively used, and an improved pattern of steel rails. Princeton College, in 1843, conferred upon him the title of A. M.

At the time of his death he was President of the American Society of Civil Engineers, to which office he was elected last January, and also President of the United Railroad and Canal Companies of New Jersey.

His funeral took place last Thursday from Lambertville, which has been his home for the past fifty years, a special train for the accommodation of members of the society leaving this city at 11:10 A. M.

LITERATURE.

Rocks, Minerals, and Stocks. By Frederick H. Smith. The Railway Review: Chicago, 1882. 12mo. 234 pages.

Amateurs in geology and mineralogy, and engineers who turn to these subjects for recreation in their moments of leisure, will find this work one that gives in a handy shape and a popular style much interesting and valuable matter. The part on rocks tells how the world was evolved and how the strata were formed, and describes the various deposits. The part on minerals describes the most important ores and minerals, and tells how they are used in the arts. There is a good deal said about mines and mining. As miners are apt to speculate, a chapter on stocks is properly added at the end, in which the practices and tricks of stock dealing are explained. This chapter furnishes amusement as well as instruction.

Applied Mechanics. By Henry T. Bovey, M.A., Professor of Civil Engineering in M'Gill University. Montreal: 1882. Octavo, 150 pages.

About fifteen years ago the author of a book on roofs and bridges said in his preface that, notwithstanding that the subject of strains had been ably treated again and again, his design in writing was to supply a want long felt in the profession. Since that time many works have been written and published on the subject of strains, some of which have been able, and all of which have had more or less value, and yet the want of just the right kind of a book is still felt by engineers and by teachers in technical schools. And to supply this want new books are continually appearing. Bridge engineers look at the subject from one point of view, professors from another, and learners from one still different. The theoretical man looks at the subject of strains in a mathematical light, and often beclouds it with algebraic symbols: the practical man looks at it only as one of the least important steps in making the design. Owing also to the very deficient courses of instruction in elementary mechanics given in this country, students taking up such a topic come to it with very different degrees of capacity, and often find the authors shooting over their heads in the first half-dozen pages. Hence it happens that there always exists a want for a good treatise on strains, and hence so many new books are published and sold.

The work before us consists of six chapters—an introductory one on frames, one on roof trusses, one on bridge trusses, one on suspension bridges, one on arches, and the last on details of construction. The method of treatment is a combination of the graphical and the analytical, the latter being usually followed. The methods are explained in general, and no numerical examples or strain sheets are exhibited. There are, however, given over a hundred problems as exercises for the reader or student. The subject is everywhere presented very concisely, and apparently in a way such as a professor might lecture to a class which had had a thorough course in elementary mechanics and in the theory of the elasticity of materials. The specifications given on pages 72 and 73 for the tests of the materials used in bridges we refer to in particular as models of conciseness and clearness, as well as stating sound engineering practice. The value of the work, we think, would have been increased if the chapter on arched ribs had been omitted, and the space devoted to the numerical discussion of the common roof and bridge trusses. Very few engineers ever have anything to do with building a ribbed arch, and we doubt if many engineering professors ask their students to study its complex theory.

Professor Bovey has printed no preface in his book. A preface is usually an advertisement put in to lure the public and save trouble to the reviewers, and its absence shows that the author is willing to let the work rest on its own merits. This it is abundantly able to do, and while, of course, it does not satisfy the long-felt want, it may do as much to advance and protect the theory of strains as larger and more pretentious works.

Report on the Character of Six Hundred Tornadoes. By Sergeant J. P. Finley, Signal Corps, U.S.A. Washington: U. S. Signal Office, 1882. Quarto, 19 pages.

Tornadoes are usually regarded as of rare and infrequent occurrence, but this carefully compiled report shows that in the year 1881 alone there were in the United States as many as eighty-four, some of which were of a violent and destructive character. One in Mississippi destroyed twenty-seven buildings and killed ten persons; one in Missouri demolished eight buildings and killed nearly fifteen persons; one in Pennsylvania destroyed property worth $40,000; one in Kansas caused a loss of $150,000, killed five persons and wounded twenty-two; one in Minnesota caused a loss of about $400,000, killed six persons and wounded fifty-three; and so on through a long list. For the year 1880 over a hundred tornadoes are reported and described, many being very destructive. The one of April 18, in Missouri, for instance, demolished over two hundred buildings, killed sixty-five people, wounded two hundred, and caused a loss of over a million dollars.

Tornadoes occur most frequently in June or the

summer months. More are reported from Kansas than any other State. They are most liable to occur during the afternoon hours of the day. They always move from the west toward the east. The velocity of progression of the storm cloud, as determined from the reports in 130 cases, varied from twelve to sixty miles, the average being thirty miles. The average time consumed by the cloud in passing a given point is about 6.5 seconds. The length of the tornado track varies from two to 250 miles, the average being twenty-eight miles. The velocity of the wind within the cloud vortex is variously estimated at from seventy to 800 miles per hour, the average being 392 miles. The rotary movement of the whirling cloud is invariably from right to left. Of the 600 tornadoes described, 134 are reported as unusually destructive. The least danger to life and property is on the left side, or north of the storm path. Very few wooden buildings will withstand the terrific whirl of the tornado cloud.

Bridge engineers usually allow about forty pounds pressure per square foot on vertical surfaces for the force of the wind. This is probably sufficient for all winds except those of the tornadoes. It would be impracticable, of course, to design the members of a roof or bridge to resist winds that are powerful enough to lift up the whole structure bodily, but we doubt if sufficient attention has been given to the general subject of wind action. Winds blow by gusts, and the action on the bridge is that of shocks of suddenly recurring intensity, whose effect is very different from that of the supposed static pressure of forty pounds per square foot. The Signal Office has done a good work in publishing this interesting and valuable report on tornadoes.

Van Nostrand's *Engineering Magazine* for October contains original contributions from William Paul Gerhard, Civil and Sanitary Engineer, Newport, R.I., on "House Drainage and Sanitary Plumbing;" from R. Randolph, C.E., on "Pile-Driving Formulas and Practice;" from Lieutenant H. H. Ludlow, Third Artillery, U.S A., on "Sub-Scales, including Verniers;" and from Professor William Cain, C.E., on "Trusses, with Superfluous Members." The price of single numbers of this magazine is fifty cents.

PERSONAL.

WM. MURDOCK, chief engineer of the Manitoba & Southwestern road, has been appointed to a similar position on the Souris & Rocky Mountain road.

J. E. TURK, chief engineer of the Valley Road (Ohio) has been appointed acting superintendent in addition to his present duties. Headquarters at Canton, O.

A PARIS dispatch of the 27th instant announces the death of M. LELANCHÉ, inventor of the Lelanché electric pile and other improvements in electricity. He invented the battery used with most of the telephones in the United States.

ENGINEERS AND ENGINEERING IN FOREIGN LANDS.

[Specially translated and prepared for ENGINEERING NEWS.]

METHODS FOR THE RAPID CALCULATION OF EARTHWORK.

A simple and rapid method for estimating earthworks is a *desideratum* for engineers, not that methods do not already exist that partially fulfill these requirements, but they do not apply as generally as might be desired. A communication from M. Pellis was lately read before the Engineer's Society of the Pays de Vaud (Switzerland) which will be of interest to engineers.

In some districts the profiles across a railway, canal or road line often present the natural lay of the ground in the form of a straight line, more or less inclined. A ground, on the other hand, that is naturally broken up may be often replaced by means of known methods, by a single straight line *AB* (fig. 1).

The theorem which we propose to demonstrate is as applicable to cuttings as to embankments, and allows us to replace the rectilinear and inclined ground *AB* by a horizontal ground, *PN*, which does away with the element of the slope of the ground,

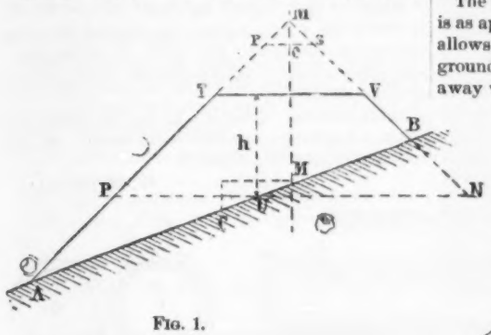


FIG. 1.

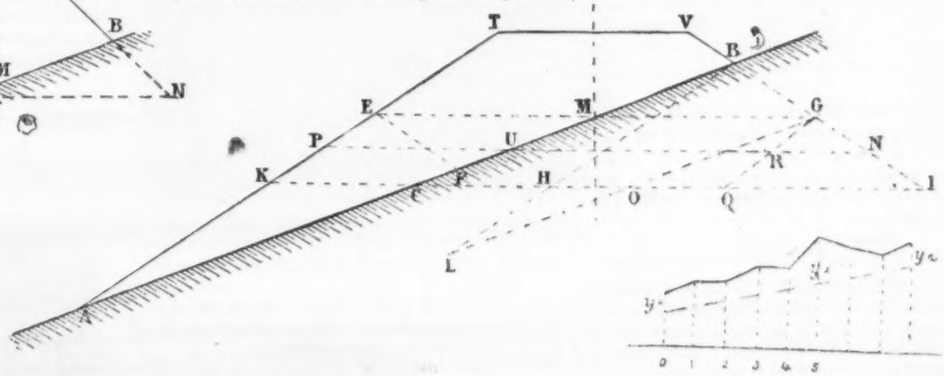


FIG. 2.

FIG. 3.

and consequently allows the surface of the earthwork to be found in a table with simple entry calculated beforehand in the function of the height of *h*—the correction being easily made by means of a second table, which will be also prepared before. The theorem is as follows:

Theorem.—Let *M* be the intersection of the axis of the platform with the ground *AB*, and let *C* be the middle of *AB*. The surface sought *ABVT* is equal to the surface *PNVT* (limited by the horizontal *PN* which passes through the point *U*—middle of *CM*) lessened by one-fourth of an isoceles triangles *M' r s*, the height of which is the difference in level of the points *M* and *C*, and its equal sides two lines *M'r* and *M's*, having the inclination of the embankment slope.

All that is therefore requisite is to determine the position of *C*, then that of *U*, which is done very quickly in practice. The vertical distances from *U* to the platform are then measured, and also those from *C* to *M*. The two calculated tables are then entered on by these vertical distances. Then the surface given by the second table is deducted from that of the first.

Demonstration (fig. 2).—The horizontal *EG*, which passes through the point *M*, leaves a trapezium, *ETVG*, above it, which is less than the surface sought by the triangle, *AEF*, obtained by drawing *EF* parallel to the slope *VG*.

On the other side the horizontal *KI* carried through the middle *C* of *AB* leaves the trapezium *KTVI*, which is greater than the surface sought for by a quantity equal to the triangle *BHI*, which is obtained by drawing *BH* parallel to the slope *TA*.

But *EF=BG*, as these lines belong to the two equal triangles *EFM* and *MBG;* if, therefore, we draw the line *GL* through *G*, parallel to the natural ground *AB*, to the point of meeting *I*, with *BH* prolonged, the two triangles *AFE* and *LGB* will be equal, and we shall have *BL=EA*. But we have also *HB=AK*, these lines belonging to the two equal triangles *HBC* and *CKA;* therefore, lastly, *LH=KE*, and by drawing *GQ* parallel to the talus *TA* we have:

$$LH=GQ,$$

from which we conclude that the angles *LHO* and *GQO* are equal, and that, consequently, the triangle *AEF* is equivalent to the trapezium *BHQG*.

Now the surface sought for *ATVB* is the mean between the trapezoidal *ETVG* and the truncated surface *ETVGQ*, since the one, *ETVG* is less than it by a quantity equal to the trapezium *BHQG*, while the other, *KTVGQ*, is greater than it by this same trapezium. We can therefore put down:

$$Surf.\ ATVB=\frac{Surf.\ ETVG+Surf.\ KTVGQ.}{2}$$

Or, again, by adding and subtracting a same quantity:

$$Surf.\ ATVB=\frac{Surf.\ ETVG+Surf.\ KTVGQ-Surf.\ PEGN;}{2}$$

Or, again:

$$Surf.\ ATVB=\frac{Surf.\ PTVN+Surf.\ PTVN-2\ Surf.RGN}{2}$$

or, lastly, superficies *ATVB*=superficies *PTVN*—superficies *RGN*, which had to be demonstrated; for the superficies of the triangle *RGN* is one-fourth that of the triangle *QGI*.

As the triangle *RGN* is generally very small with relation to the superficies *PTVN*, the correction may be omitted and the figure of the embankment *ATVB* may be calculated in a rapid and practical way by looking on the plan for (1) the point *G* situated at an equal distance from the two extremities of the talus; (2) the mean point *u* between the axis picket and the point *C*. The offset for cutting or embankment is measured on this point *u*, and the corresponding superficies is found in the tables or calculated from the formula:

$$S=lh+fh^2;$$

l— the breadth of the platform and *f* the relation of the base of the talus to its height.

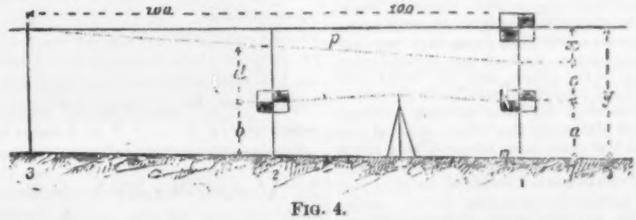


FIG. 4.

Application of Simpson's Formula.—Lalanne gave previously the following application of

Thomas Simpson's formula for calculating earthworks by finding the best line for equalizing between cuttings and embankments, by means of successive approximations. If the ground is not horizontal in the transversal sense, the heights between the formation level and that of the natural ground, which is found by the preceding method (fig. 3), may be used:

$$V = d\left[A\left(\frac{y_0 + y^n}{2} + \Sigma y\right) + 3\left(\frac{y_0^2 + y_n^2}{4} + \Sigma y^2\right)\right].$$

d = equidistance of the offset in even numbers.

A = breadth of platform of embankment or cutting.

Method for Adjusting a Fixed Level.

English surveying instruments being composed of an eye-piece and air bubble, the parallelism with the optical axis cannot be regulated by reversing as in the French instruments. The levels can be regulated, however, by the following method:

Three points, 1, 2 and 3, at equal distances, are determined on and marked by pickets. The verifying instrument is placed in the middle between points 1 and 2. The heights on the staff, a, are read off successively on point 1, and on b on point 2 (fig. 4). Whatever may be the error in level, or deficiency of parallelism between the bubble and the optical axis, the difference of level between points 1 and 2 will be $a - b$ or $b - a$. This done, the instrument is brought to point 3, and the staff heights on points 2 and 3 are taken again from the new station.

Let $a + b$ be the new staff reading on point 1, and $b + d$ the new reading on point 2, if we have $(a + c) - (b + d) = a - b$ or $c = d$, the level is right.

If the instrument is badly adjusted we shall have $d > c$ or $d < c$. The inclination p of the visual radius will be:

$$\frac{d-c}{h} \quad p; \text{ or } \frac{c-d}{h} = p;$$

h = the distance from point 1 to point 2, equal to that from 2 to 3. The parallelism of the bubble and the optical axis will be regulated by having the instrument give from station 3 at 1, a staff height equal to

$$y = a + c \pm 2 \text{ hp.} = \text{om.}$$

RECENT INVENTIONS PATENTED DURING THE PRESENT WEEK.

STREET-RAILWAY CAR.

An inventor has recently constructed a street-railway car which is provided with an entrance at its front end, wherein a compound turnstile is rotarily secured under control of the car driver. The turnstile has appurtenant ratchets and pawls whereby rotation of the stile in either direction under control of the car driver is secured.

DREDGING MACHINERY.

In this invention a frame, consisting of a cross-head, guide rods and double plates bolted thereto, with interposed pulley and pole-socket extension pieces, supports inbearings in said plates, a shaft carrying a sleeve with end-stuffing boxes. Buckets are hinged to the frame by three pairs of arms, one pair turning on a common pivot near the bottom of the above plates, another pair on separated pivots at the top of the plates, and the third pair on a shaft screwing into plates sliding on the above guide rods and secured by bolts passing through filling pieces to plates on the other side of the guide rods. To the shaft is secured a lifting chain and also the chains first mentioned. This dredger belongs to the "clam-shell" pattern.

NOVEL VELOCIPEDE.

This invention consists of three driving-wheels placed in different planes, so that it will sustain itself in an upright position. This construction is secured by a suitable frame-work connected with each wheel. There are three seats perched over each driver in the same manner as the bicycle. Three sets of pedals are used, and it is adapted for three riders, one astride of each driving-wheel.

DEVICE FOR LOADING AND LANDING FLOATING LUMBER CRIBS.

In this invention a submerged railway is employed, and the car for receiving the floating lumber-crib is backed down the track by the locomotive under the floating lumber. A floating dock or guide is used, whereby, when the engine pulls the submerged car up the incline, the crib will be deposited on the truck.

SELF-LUMINOUS PAINT.

An English invention, patented during this week, and heretofore in nearly every country in the civilized world, consists of a luminous paint, the body of which is a phosphorescent substance, or composed in part of such substance, the vehicle of which is such as is ordinarily sized in paints, viz., one which will become dry by oxidation or evaporation.

SOCKET FOR INCANDESCENT ELECTRIC LAMPS.

This week the United States Electric Light Co. have assigned to them an invention, the object of which is to hold the lamp securely in the socket, and also to inclose and protect the circuiting springs. It consists of a rotary holder having a stationary base. Springs are employed capable of being brought into or out of electric contact with the terminals of the base by the rotation of the holder in one direction. The base and holder are both composed of insulating material, and incloses the conductors. A circuit breaker is located in the base. F. B. BROCK.

WASHINGTON, D. C.

CORRESPONDENCE.

ANSWERS TO GEOMETRICAL PROBLEM.

P. Y. & C. R. R., PITTSBURGH, Pa., Sept. 18, 1882.

EDITOR ENGINEERING NEWS:

Several weeks ago ENGINEERING NEWS asked for the solution of a geometrical problem, viz.: From a point within an equilateral triangle the distances to each corner are respectively 20, 28 and 31 ft. What is the length of the sides of the triangle? The only answer to this question yet published is one from a correspondent who maintains that there is no mathematical solution possible, but gives an approximation, derived from a graphical process. And this seems to be passively indorsed.

By way of protesting against this conclusion I submit the following:

From the common point let fall perpendiculars to two of the sides of the triangle, and let one of them be produced until it intersects the opposite side. Let the base of the right-angled triangle formed by the produced perpendicular $= b$, and its hypothenuse $= a+z$; a being the distance from the angle of the equilateral to the perpendicular let fall upon it, and z the distance from this point to the point of intersection of the produced perpendicular. Let the other perpendicular $= y$. The right-angled triangle having y for base and z for perpendicular is similar to the other, and both are halves of respective equilateral triangles, the hypothenuse being twice the base, and the perpendicular $\sqrt{2^2 - 1^2} = \sqrt{3}$ times the base.

Let the side of the equilateral $= x$; then

$$x = \sqrt{\sqrt{903503} + 1072.5} = 44\ 98-$$

R. RANDOLPH, C.E.

[F. Meller, C.E., of Keystone Bridge Co., Pittsburgh, gives same solution, $x = 44.9786$.]

K. & P. R. EXTENSION, RENFREW, Ont., Sept. 11, 1882.

EDITOR ENGINEERING NEWS:

I notice in last NEWS, your correspondent Chas. J. Bates thinks there is not enough data given in Henry Thompson's problem of the previous issue. The following is the solution of the problem:

Let ABC be the given equilateral $\triangle$, D the given point. In the case before us $AD = 28$; $DC = 20$; $BD = 30$. On AD describe an equilateral $\triangle$ ADE and join EC. Then in $\triangle$s BAD, CAE, $BA = CA$; $AD = AE$, and angle $BAD = CAE$, being each in deficiency of 60° by the amount of the angle CAD. $\therefore CE = BD$. Consequently in $\triangle$ CDE we have three sides to find angle $CED = 40° 10'$. Then in $\triangle$ CAE, $\angle AEC = 60° + 40° 10' = 100° 10'$, and $AE = 28$; $EC = 30$. Solving this triangle we get $AC = 44.49$.

M. J. BUTLER.

NEWBURGH, N. Y., Sept. 18, 1882.

EDITOR ENGINEERING NEWS:

The problem of the equilateral triangle proposed by Mr. Thompson, page 289, is susceptible of a mathematical solution. Let P be a point taken anywhere, and represent the distances from it to the three vertices, A B C, of an equilateral by a, b and c, respectively, of which let a be the greatest and c the least; and let x be one side of the unknown equilateral. We then have

$$\sin. \tfrac{1}{2} APB = \sin. \tfrac{1}{2}(BPC + CPA) = \sin. \tfrac{1}{2} BPC \cos. \tfrac{1}{2} CPA + \sin. \tfrac{1}{2} CPA \cos. \tfrac{1}{2} BPC.$$

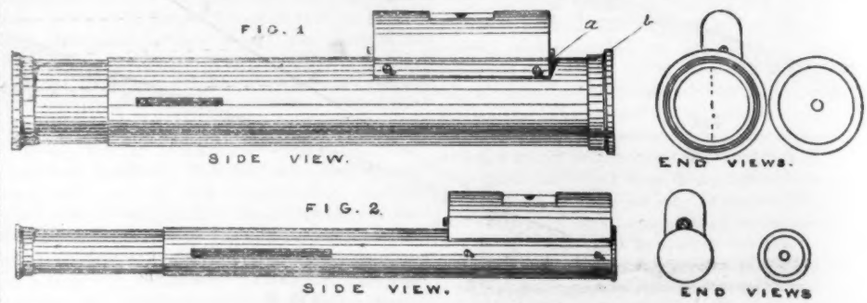
Substituting for these sines and cosines their values in terms of a, b, c and x, and reducing, we obtain the formula

$$x^2 \quad \tfrac{1}{2}(a^2 + b^2 + c^2) \pm \sqrt{\tfrac{1}{4}(a^2 + b^2 + c^2)^2 - (a\,b - c^2)^2 - (a-b)^2\,((a+b)^2 - c^2)}$$

in which the + sign before the radical gives an equilateral containing the point, P, while the − sign gives another equilateral, as $AB'C'$, which does not contain P.

In the problem stated $a = 31$, $b = 28$, and $c = 20$; hence $x = 44.97808$; but for a point outside of the required triangle $x = 11.04410$.

Respectfully, W. H. SEARLES.



IMPROVEMENT IN HAND LEVELS.

IMPROVEMENT IN HAND LEVELS.

CLEVELAND, O., Sept. 18, 1882.

EDITOR ENGINEERING NEWS:

A recent examination of the hand level leads me to call attention to some changes and improvements that might be made in the article. A pocket instrument should be as light and small as consistent with the degree of strength and accuracy required. Those who have used the level designed by Locke know the advantage of having a large "field" brought quickly before the eye, that objects previously noted may be easily recognized, and the position of the level line fixed at once.

This feature, which is in itself very important, doubtless led to designing and giving to the trade a cylinder three-fourths of an inch, and a case an inch and a half in diameter.

Let any one acquainted with the instrument, or familiar with a telescope, and especially one who has learned that he is not obliged to keep one eye closed and the face distorted during an observation, take up a hand level, and, after carefully covering the object end so as to exclude all light from that direction, put it to his eye in the usual manner.

He will first observe that the quantity of light passing downward through the level tube opening has not been diminished, and that he can bring the instrument to a level position with as little trouble as before the end was covered. If then he will use both eyes, *naturally*, looking into the closed cylinder with one and in the direction of his work with the other, he will find before him a field of such dimensions that he ought not to complain, and beside which the half cylinder area would appear insignificant, and without further effort the closed cylinder and the bubble, and even the cross-wire, will appear to be transparent, thus

permitting the center of the wire to be used in determining the position of the horizontal line, and insuring greater accuracy, as well as ease and comfort in using, than can be obtained in the ordinary manner, and for all, except such as have lost an eye, the instrument should be changed from its present form, shown in Fig. 1, to that shown in Fig. 2, both being natural size. The glass at the object end should be replaced by a metal cap; the tube and prism moved from a side to a central position; the half lens exchanged for a whole one, and the cylinder reduced in diameter as indicated.

It is difficult to understand why the cylinder was extended beyond the end of the level tube, from *A* to *B*, unless for appearance. The same increase in length at the opposite end would add something to the accuracy of the instrument.

H. F. DUNHAM.

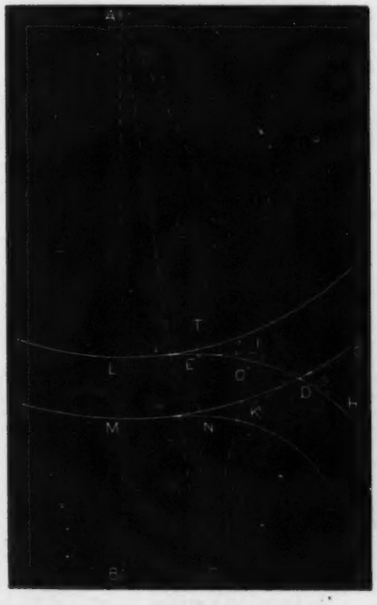
TO FIND FROG DISTANCE AND ANGLE.

WELLAND, ONT., Sept. 22, 1882.

EDITOR ENGINEERING NEWS:

Would some of your correspondents kindly say if the following solution of the problem, "To find the frog distance and angle when the main line is curved," has been published.

AL = radius inner rail, main line, call it R.
LM = gauge = g.
$MB = NC$ = radius inner rail of turnout = R'.
GDH = frog angle or angle between tangents = F.
ED = frog distance = d.
LE = switch rail; TE = throw. The length LE



should be such as will give the necessary throw, say 5 in. when tangential to main line curve at L.

$MN = BC = LE = l$.

Now in triangle ABC, $AB = R + g + R'$ and $BC = LE = l$ are known, and angle $ABC = 90°$, hence we know AC.

Now in triangle ACD we have from last the side AC, also $AD = R + g$ and $CD = R' + g$, hence we get angle ADC; but since ADG and CDH are each equal to 90°, the angle ADC is equal to $180° - GDH$ or $180° - F$; ∴ we have frog angle.

From the triangle ADC we also have the angle ACD. But angle $ACT = BAC$, which we have from right-angled triangle ABC, and angle $ECD = ACD - ACT$; ∴ we have ECD.

Now in the right-angled triangle EOC, $EC = EN + NC = g + R'$.

Angle $ECO = \frac{1}{2}$ ECD, but

$EO = EC \times sine\ ECO$; ∴ we know EO, also $ED = 2\ EO$, but ED is the frog distance—Q. E. D.

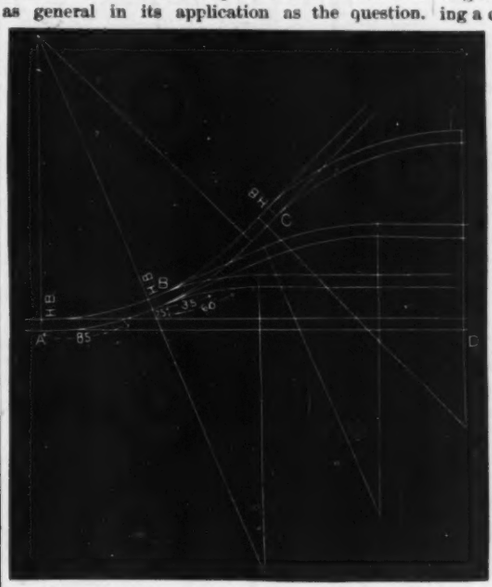
B. A.

STAKING OUT SWITCHES.

MEXICAN CENTRAL RAILWAY COMPANY, LIMITED. ENGINEERING DEPARTMENT. PASO DEL NORTE, Mexico, Sept. 19, 1882.

EDITOR ENGINEERING NEWS:

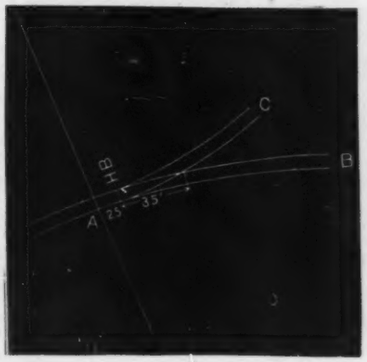
A correspondent "F. D.," in ENGINEERING NEWS of Aug. 26, asks: "What is the practical work for staking out a switch on the ground, frog being on the ground, and for the various ones now in use." Your issue of Sept. 9 contains an answer as general in its application as the question.



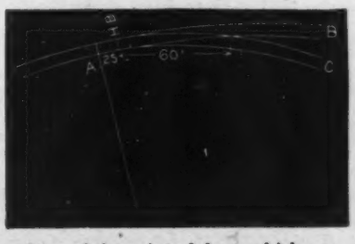
However, this treatment of the subject is so different from the methods I have seen employed, that I venture to give a few cases of a different treatment.

Let us suppose AB the first siding in a yard, and the other lines a system of storage tracks. At A, we will use a split switch, at B a three-throw stub, and at C a single stub switch. We have on hand say frogs No. 9 and 6½, and empoly for a turnout curve a 7° 30′.

First Case, A.—This being a split switch, we place the head block stake, marked HB, at the point of curve; or since the switch rail is not cut



to a mathematical point, it is, perhaps, better to place the HB some eight feet inside the PC. It will be sufficient to place stakes every 50′ on the remainder of the curve, and let the trackman curve the rails by his eye when he surfaces up.



The position of the point of frog, which we mark on the rail, is found as follows: The radius of the turn-out, less the gauge of the track, equals the cosine of the angle, which, divided by the radius, equals the cosine to radius one. This angle divided by the degrees of the curve and multiplied by 100 gives the lead to the frog.

Second Case, B.—Here we have a three-throw stub-switch. The switch rail, 30′ long, is spiked up 5′, leaving 25′ of moveable rail. At the free end is the head block; and the PC is supposed to be 25′ back. The throw of the switch 5″ differs from the ordinate of a 7° 30′ curve 25′ from its origin by $\frac{1}{100}$ of an inch, and the switch rail, taking a curve due to the elasticity of the steel and friction of the ties, differs slightly from a circle; but for all practical purposes it is part of the 7° 30′ turn-out.

Where two turn-outs, right and left, cross each other we use a 6½ frog, and find its distance from the head-block as follows: The two 7° 30′ curves make the same angle with each other at the point of crossing as a 15° curve off a tangent. Therefore the radius of a 15° curve, less the gauge, divided by the radius, gives the cosine of the crossing angle. This angle divided by 15° and result by 100 gives the lead from the PC, and 25′ from this the lead from head-block. The No. 9 frogs, where the turnouts cross the tangent, will be located as in the previous switch. In staking out this switch I would place a track center at the head-block marked HB, another center at the middle frog marked CF, while at the long frogs I would place stakes *at* the frog points marked PF and track centers just opposite, not marked.

At the switch C put in a head-block stake, a center at + 50, another opposite the PF and a stake at the frog point.

When the turn-out is off a curve we can often use a No. 9 or 6½ frog in this manner.

Suppose AB a 3° curve. Add 3 to the standard turn-out curve 7° 30′, and this gives the degree of the turn-out curve we must run off to employ a No. 9 frog.

To get off the 3° curve AB, on the other side, we use the 6½ frog, which fits a 15° curve off a tangent. The degree of the turn-out AC equals 15° less the degree of AB.

In the first case the lead to the frog is the same as for a 70° 30′ curve off a tangent, and in the second it equals the lead of a 55° curve off a straight track.

These points can be demonstrated by comparing the equations of the curves AC and AB with those of 7° 30′ and 15° curves crossing straight lines, if not by some easier method.

Yours respectfully, G. M. R.

NOTES.

SCIENTISTS DISCUSS LUDLOW WATER.

Charles Mayr read a paper on Ludlow water before the Springfield Science Association last evening. He gave a detailed topography of the reservoir, stating that the large reservoir contains too many shallow bays; that the water near the gate-house is very green, but almost odorless; that near the northwest end it is thickish green and has a slightly fishy odour; that near the Cherry Valley it is brownish but clear. In the Belchertown Reservoir it is very boggy, and a little current passes about 100 gallons into this smaller reservoir, which flows out at one gate. The speaker had analyzed the water frequently, and found the average to be about three grains of solids in a gallon. By analysis he found that filtering would remove about one-tenth of a grain from a gallon, this being the amount that now reaches the city, or about 40 pounds a day of algæ. This is a comparatively small amount, as the Ludlow pond might contain about six tons of the algæ. The trouble in the water, therefore, is in the pipes, since the water at Ludlow smells sweet, but arrives putrid at the faucets. The question, then, is, What is done in the pipes? Probably the algæ, stagnating and decaying in the pipes, produce the odor, for water without the decaying mass is odorless. Prof. Mayr recommends scientific flushing, so that even the smallest pipes may be cleared and supplied with filtered water. The filters will soon become fouled, and will have to be changed often. A discussion of the paper followed, participated in by City Engineer Ellis, who

was glad to find substantial agreement as to the difficulty, and thought that flushing can be done in the best manner by proper flush-gates, and the matter in the pond best removed by filtering. Prof. Pillsbury suggested that it might be possible that decaying animals, instead of plants, produce the trouble. He thought the animal contained in the clear jelly-like balls so abundant everywhere produces something to rival Ludlow-water odors. Dr. Calkins says he has noted a decrease of typhoid since the introduction of Ludlow water and sewers, but in the case of the home of the friendless he had observed that little damage was done by the Ludlow. Mr. Ellis alluded to the fact that European cities, like Berlin, have the same kind of water in the reservoir, and yet furnish good water to the population by proper filters. At the close of the discussion a committee was appointed to draw up resolutions on the death of Dr. Lawton.—*Springfield Republican, Sept.* 14.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

RAIN-FALL AT THE CROTON DAM.—Complete returns of the recent rain-fall and its effects in the Croton Valley have not yet been received by the Department of Public Works, this city. The partial reports, however, showed that at the Croton dam the water before the storm was 18 in. below the top. Monday morning 41 in. of water was running over the dam, equivalent in one day to a thirty-five days' supply for this city. The rain-fall at the dam was 11.26 in., while at the reservoir in Central Park the fall was 13.18 in. The storm caused one or two wash-outs along the Croton pipe line, and the pipe was broken at Tenth avenue and Seventy-third street, but no damage was done that could not be quickly and cheaply repaired.

PRICE OF GAS REDUCED IN PHILADELPHIA.—The Gas Trust has decided to reduce the price of gas to private consumers, and to light the public lamps free of charge. The price to consumers will be $1.90 per thousand.

A NORTHAMPTON, MASS., note says: Though the water question is pretty definitely settled till next summer, the commissioners propose to mature plans for another year, and are having estimates made for a new reservoir some distance above the present one. The farmers who own the little pond which it was proposed to turn into the brook hold it at a high price, and, as another reservoir would not cost very much, the pond may not be bought.

ELECTRICITY.

ELECTRIC LIGHT IN PASSENGER CARS.—It has been the intention of the Pennsylvania Central Railroad, for some time, to try the experiment of lighting its passenger-cars with electricity instead of gas. The first car equipped with electric light arrived at Philadelphia on the southern express Monday night. Seven lamps of the Edison pattern brilliantly illuminated the interior of the car. The electricity is supplied by a Faure's secondary battery, which is attached to the bottom of the car. The electricity is generated by a dynamo-electric machine and forced into the battery, where it is stored for use. In the battery used in making the experimental test sufficient electricity was stored to supply seven lights for seventeen hours. The light produced is about eight candle power, and is operated by a switch in one end of the car. The experiment was made under the direction of Mr. Lachlan, the electrician, who superintended the introduction of the light into the cars of the London, Brighton and South Coast Railroad Company in England. If the experiment proves a success it is the intention of the company to introduce the light in all its passenger coaches.

STREETS, DRAINAGE, ETC.

KEENE, N. H., has contracted with the Drainage Construction Company, of Boston, for a complete system of sewerage, for $82,000. The total length of sewers will be between 12 and 13 miles.

THE HOBOKEN MEADOWS.—For many years past the matter of filling in the meadow district of Hoboken has been agitated by the people of that city. Many meetings in favor of the project have been held, but no good has ever come of them. On Saturday last the district, which covers an area of about two miles, was completely inundated, and has remained so ever since, the residents being compelled to use boats or rafts to get to or from their homes. The matter of filling in the district was revived at the last meeting of the Common Council. Every member of the board was satisfied that something ought to be done, but they were unable to decide which would do the most good, the filling in or pumping systems, and they decided to have the matter voted upon by the people at the coming election.

SEWERAGE FOR LONG BRANCH, N. J.—At a public meeting held on the 21st inst. an engineer explained that a main sewer could be built from North Long Branch to Green Pond, with two reservoirs and the pumps needed to force the sewage out to sea, at a cost of about $50,000. Dr. Thomas G. Chuttle, Dr. S. H. Hunt, R. J. Dobbins, D. M. Hildreth and Wilson D. Haven were appointed to prepare a report upon the necessity of sewering the town at once, the best plan of sewerage, and how to raise the money needed for the work, as the town has no power given in its charter to proceed with a work of the kind.

ALCONA COUNTY, Mich., is considering a proposition to issue bonds for $20,000 to construct gravel roads.

THE POTOMAC FLATS.—The plan of Major Haines for the improvement of the Potomac Flats has been approved by the Chief of Engineers, and by him submitted to the Secretary of War, with the recommendation that the work be done by contract with the lowest bidder, after due advertisement for proposals. The plan was approved by Secretary Lincoln. Three objects are to be accomplished by the proposed improvement—the improvement of navigation, the establishment of harbor lines and the raising of the flats. The estimated cost is $2,716,509.

RIVERS AND HARBORS.

THE MISSISSIPPI LEVEES.—A Memphis, Tenn., dispatch of the 25th says: The board of engineers to-day noon opened bids that had been filed for the repair of the broken levees on the Mississippi River. Proposals for the entire work had been received, but as yet no awards are made. The bids average 22½ cents per cubic yard for levees on the Mississippi side of the river and 25 cents for the Louisiana side.

BIDS FOR BUILDING JETTIES.—The following bids have been received by Gen. Q. A. Gillmore at the Army Building this city for dredging and jetty building at the South: For dredging Wappoo Cut, South Carolina, the Charleston Dredging Company, at 16 cents per cubic yard for the first mile, 18 cents for the second, and 20 cents for the third mile. For the building of a jetty in the harbor of Brunswick, Ga., there were three bids, as follows: John C. Provost, 85 cents per square yard, $1 brush, $3.50 per cubic yard stone; James E. Walter $1.13 per square yard, 26 cents brush, $3.25 per cubic yard stone; William H. Adams, $2.20 per square yard, 50 cents brush, $3.75 stone. For dredging the Brunswick harbor, James E. Walter bid 27 cents per cubic yard for sand or sand and loam mixed, clay or shell, or marl stone. For the improvement of Volusia Bar, Florida, there were two bids—George A. Decotles, 95 cents per square yard for mattress, $5.95 stone per cubic yard, $6 each per piles driven; L. A. Cunningham, $1.05 mattress per square yard, $7.25 stone per cubic yard, $12 each per piles driven.

RAILROADS.

THE NEW MEXICO AND ARIZONA ROAD.—The New Mexico & Arizona Railroad is now operated from Benson to Calabasas, on the southern border of Arizona. This is the road which is to connect the Sonora road from Guaymas, on the Gulf of California, with the Santa Fe. The Sonora road is completed to Magdalena, a Mexican town about 60 miles south of Calabasas, and a stage covers the distance between the ends of the railroads, which are being constructed as rapidly as possible. It is expected that this gap will be closed up within 30 days. When the line is opened to Guaymas, nearly 1,700 miles distant from Atchison, it will be operated by the Santa Fe, and the line will be the longest railroad in the world under one management. The new line will also open the shortest route to Australia, 1,400 miles shorter than by way of San Francisco. The harbor at Guaymas is said to be one of the finest on the Pacific coast.

RAPID RAILWAY CONSTRUCTION.—The swiftest railroad building ever done is now in progress along the line of the Canadian Pacific. The following are official figures of daily building, cover grading, track laying and bridging, all complete, with side-tracks, whose length is not counted. Here is the record:

Days.	Miles in decimals.	Days.	Miles in decimals.	Days.	Miles in decimals.
July 31	2.49	Aug. 14	3.40	Aug. 28	4.10
Aug. 1	3.85	Aug. 15	3.10	Aug. 29	3.50
Aug. 2	3.59	Aug. 16	2.72	Aug. 30	3.70
Aug. 3	3.94	Aug. 17	2.94	Aug. 31	3.60
Aug. 4	3.52	Aug. 18	1.66	Sept. 1	3.40
Aug. 5	3.35	Aug. 19	4.05	Sept. 2	3.60
Aug. 7	3.08	Aug. 21	3.35	Sept. 4	3.40
Aug. 8	2.76	Aug. 22	2.95	Sept. 5	2.30
Aug. 9	3.10	Aug. 23	2.95	Sept. 6	2.35
Aug. 10	2.61	Aug. 24	3.26	Sept. 7	3.35
Aug. 11	2.53	Aug. 25	3.50	Sept. 8	3.80
Aug. 12	2.90	Aug. 26	3.40	Sept. 9	3.20

NEW LINE TO EVANSTON.—The new Chicago & North Evanston railway has now secured the right of way from Evanston to the intersection of North avenue and Larrabee street. It is said that the Chicago, Milwaukee & St. Paul road has secured control of the company, and will build the road and run suburban trains from Evanston direct into the union depot on Canal street.

TRACK LAYING COMPLETED.—Track laying on the Nevada & Oregon Railroad was completed Sept. 18 to Roberts and Antelope stations in Long Valley, Cal., about 30 miles north of Reno, Nev., and regular freight and passenger trains commenced running from Long Valley to Reno, where connection is made with the Central Pacific and Virginia & Truckee railroads. The road will be extended this fall to Honey Lake Valley, and during 1883 to Goose Lake, at the Oregon State line. This road will run east of the Sierra Nevada Mountains through a well-settled country now without railroad facilities.

A NEW YORK ROAD CHARTERED.—The Binghamton & Williamsport Railroad Company, of Binghamton; capital, $400,000. The length of the railroad is to be 20 miles, and is to run from Binghamton to a point on the division line betwen New York and Pennsylvania, and thence by the most feasible route to Williamsport, Penn.

RAILROADS AND THE MONEY SUPPLY.—It is estimated that fully ten thousand miles of railroad will be added to the facilities of the United States during the year 1882. This is exclusive of a considerable addition of lines in Canada and Mexico, in which American capital is interested; in the latter alone there are fully 2,500 miles under contract, and, taking the continent together, it is not unreasonable to suppose that we are under obligations for the cost of fully 12,500 miles of road this year, a greater extent next year, and so on as long as the supply of loanable capital holds out. Much of the road now building is in either the old and settled country or in the inaccessible wild West; some of it is double track, and most of it laid with steel rails, and an uncommon proportion of it in rugged and mountainous *terrain*. A fair estimate of cost would be not far from $25,000 per mile. This involves an outlay of from $300,000,000 to $350,000,000 per annum for a single form of internal transportation improvement. Can the country stand such a drain upon its industry and income? This is altogether a different question from that whether the expenditure is, on the whole, a provident one. We can, in one sense, afford it; but can we pay as we go? If not, can we get credit at fair rates? Where is the money to come from?

ROAD GRADED.—Half the road from Doniphan to Neeleyville, known as the Doniphan Branch of the Iron Mountain, has been graded and ties and bridge timber distributed along the line. The road will be completed and ready for operation by the 1st of December next.

ROAD INCORPORATED.—The State Department at Harrisburg, Pa., has chartered the Phœnixville, Pottstown & Reading, and the Philadelphia, Norristown & Phœnixville railroad companies. The companies have a capital stock of $1,000,000 each, and both will be operated by the Pennsylvania Railroad Company.

A NEW RAILROAD OPENED.—The Redstone Branch of the Pittsburgh, Virginia & Charleston Railroad was opened on the 25th.

NEARLY thirty miles of grading have been finished on the railroad between Arcadia and Shreveport, La.

THE MILWAUKEE & LAKE WINNEBAGO.—The Milwaukee & Lake Winnebago Railroad, being built in the interest of the Wisconsin Central, from Neenah to Milwaukee, is fast approaching completion, and will be ready for regular trains about Oct. 31. From Neenah to Oshkosh the road runs side by side with the Chicago & Northwestern; from Oshkosh to Fond du Lac the two roads do not diverge many rods at any place. From Fond du Lac the new road extends to Schleisingerville, and then runs into Milwaukee over the track of the Chicago, Milwaukee & St. Paul.

THE OTTAWA & GATINEAU VALLEY RAILROAD, Ottawa, Sept. 27.—Arrangements have been completed by which Mr. Edward Bates Denny, President of the United States Mining and Investment Company, with its headquarters in New York, in connection with English capitalists, will undertake the construction of the Ottawa & Gatineau Valley Railroad. It is said that there is a scheme on foot to amalgamate this company with the Ottawa, Waddington & New York Railway & Bridge Company.

THE GUNNISON EXTENSION of the Denver & South Park Railway has been completed.

IMPORTANT RAILWAY LEASE.—Columbia, S. C., Sept. 24.—The Charlotte, Columbia & Augusta Railroad has leased the Chester and Lenoir Narrow Gauge Railroad for a period of 90 years. This road runs from Chester, S. C., to Lenoir, Caldwell County, N. C., a distance of 110 miles. Seventy-two miles of the road have been built and are now in running order. The lessees guarantee the completion of the line from the present terminus to Lenoir within 18 months from the date of lease.

CANALS.

A CANAL PROJECT IN GERMANY.—A dispatch from Berlin says the Government intends to devote its attention to the execution of a project for the construction of a canal connecting the North Sea with the Baltic.

CONTRACTS LET.

STONE CONTRACT LET.—The contract for supplying the curb stone for the approaches to the north wing of the state, war and navy department building at Washington has been awarded to Daves Tileston, of Rockland, Maine, for $53,648.

GEORGE H. CORLISS, of Providence, has the contract to supply the pumps and engine for Pawtucket's, R. I., new pumping station. Two pairs of horizontal pumps, with a capacity of 1,500,000 gallons a day, will be set up at a cost of $21,000.

A DREDGING CONTRACT LET.—A Baltimore note of the 21st says: The United States Engineer's Office, in charge of the harbor defenses of the city, has been authorized by the proper department at Washington to enter into a contract accepting the proposal of a New York dredging company to dredge 2,500,000 cubic yards in the approaches to this harbor at sixteen cents per cubic yard.

PUMP CONTRACT LET.—St. Louis office of Henry R. Worthington, Frank H. Pond representative, has contracted to furnish the pumping engines, one million gallons capacity, for Tyler, Texas.

BUILDING.

PROPOSALS FOR BRICKS.—The Cincinnati Gas-Light & Coke Company will receive bids up to Oct. 14, for five million bricks.

LABOR.

THE Board of Aldermen of this city have passed a resolution requesting Street Commissioner Coleman to pay his employés $2.00 per day.

BRIDGES.

BRIDGE IN LOWELL, MASS.—The City Council has voted to build a pile foot-bridge in place of the present floating bridge, to connect Centreville with the main city. Work has commenced on the piers of the new iron bridge, to replace the Central bridge, recently burned.

THE work on the new bridge at Shreveport, La., is progressing satisfactorily. The bed of Red River at Shreveport, by the way, has filled in 7 ft. within the last week, changing from 21 ft. to 14 ft. of water.